JC05 Rec'd PCT/PTO 28 NOV 2001

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U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NO
ALIEV ET AL. (PCT)

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

U.S. APPLICATION NO. (if known, see 37 CFR 1.5)
09/980157

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/RU00/00144	21 APRIL 2000	28 MAY 1999

TITLE OF INVENTION
SYSTEM FOR ILLUMINATING AN OBJECT

APPLICANT(S) FOR DO/EO/US
ABDULLA SIRAZHUTDINOVICH ALIEV ET AL.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. X This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ___ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. X This is an express request to begin national examination procedures (35 U.S.C. 371 (f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(l).
4. X A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. X A copy of the International Application as filed (35 U.S.C. 371(c)(2)
   a. X is transmitted herewith (required only if not transmitted by the International Bureau)
   b. ___ has been transmitted by the International Bureau.
   c. ___ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. X A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ___ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).
   a. ___ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ___ have been transmitted by the International Bureau.
   c. ___ have not been made; however, the time limit for making such amendments has **NOT** expired.
   d. ___ have not been made and will not be made.
8. ___ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. X An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ___ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. X An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ___ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. X A **FIRST** preliminary amendment.
    ___ A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. ___ A substitute specification.
15. ___ A change of power of attorney and/or address letter.
16. X Other items or information:

PCT/ISA/210 - Int'l. Search Report (English)
9 sheets of formal drawings

Applicants Claim Priority under 35 U.S.C §119 of Russian Application No. 99111294 filed May 28, 1999.
Applicants Claim Priority under 35 U.S.C. §120 of PCT/RU00/00144 filed April 21, 2000.

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APPLICATION NO (if known, see 37 CFR 1 5) 09/980157	INTERNATIONAL APPLICATION NO PCT/RU00/00144	ATTORNEY'S DOCKET NO ALIEV ET AL.
X The following fees are submitted.	CALCULATIONS	PTO USE ONLY
Basic National Fee (37 CFR 1.492(a)(1)-(5)): Search Report has been prepared by the EPO or JPO..................**$890.00**		
International preliminary examination fee paid to USPTO (37 CFR 1.482) **$690.00**		
Neither international preliminary examination fee paid (37 CFR 1.82) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO.........**$1,040.00** International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4)..........**$100.00** **ENTER APPROPRIATE BASIC FEE AMOUNT =**	$ 1,040.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than ___ 20 ___ 30 months from the earliest claimed priority date (37 CFR 1.492(e))		

Claims	Number Filed	Number Extra	Rate		
Total Claims	12 - 20 =	- 0 -	X **$18.00**	$	
Independent Claims	1 - 3 =	- 0 -	X **$84.00**	$	
Multiple dependent claim(s) (if applicable)			+ **$280.00**	$	
TOTAL OF ABOVE CALCULATIONS =				$ 1,040.00	
Reduction by 1/2 for Small Entity status.				$ 520.00	
SUBTOTAL =				$ 520.00	
Processing fee of **$130.00** for furnishing the English translation later than ___ 20 ___ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
TOTAL NATIONAL FEE =				$ 520.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +					
TOTAL FEES ENCLOSED =				$ 520.00	
				Amount to be: refunded	$
				charged	$

X Applicant claims Small Entity status.

a. X A check in the amount of $ 520.00 to cover the above fees is enclosed.

b. ___ Please charge my Deposit Account No. 03-2468 in the amount of $________ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. X The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment, to Deposit Account No. 03-2468. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:
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Edward R. Freedman
Signature

Edward R. Freedman
Reg. No. 26,048

EXPRESS MAIL NO. **EL 871 449 956 US**
Date of Deposit November 28, 2001

I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 C.F.R § 1 10, on the date indicated above, and is addressed to the Box PCT, U.S. Patent and Trademark Office, P.O. Box 2327, Arlington, VA 22202

Lisa L. Vulpis
Lisa L Vulpis

09/980157
JC03 Rec'd PCT/PTO 28 NOV 2001

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANTS: ABDULLA SIRAZHUTDINOVICH ALIEV ET AL. (PCT)

PCT NO.: PCT/RU00/00144

FILED: APRIL 21, 2000

TITLE: SYSTEM FOR ILLUMINATING AN OBJECT

PRELIMINARY AMENDMENT

BOX PCT
Ass't. Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Preliminary to the initial Office Action, please amend the above-identified application as follows:

IN THE SPECIFICATION:

On Page 1, above line 1, please insert the following paragraphs:

--CROSS REFERENCE TO RELATED APPLICATIONS

Applicants claim priority under 35 U.S.C. §119 of Russian Application No. 99111294 filed May 28, 1999. Applicants also claim priority under 35 U.S.C. §120 of PCT/RU00/00144 filed April 21, 2000. The international application under PCT article 21(2) was not published in English.--

IN THE CLAIMS:

Please cancel Items 1-12 (claims 1-12) and replace them with new claims 13-24 as follows:

--13. The system for lighting of an object includes a source of radiation, the first guidance device optically integrated with an object, and the first mirror, kinematically bound with the first and the second actuators; the system is distinguished by the additional second guidance device, the first and the second subtracting amplifier, a commutation unit, the third and the fourth actuators, and the second mirror, kinematically bound with the third and the fourth actuators; inputs of these actuators are connected to the corresponding outputs of the commutation unit, whose first and second input are connected to the outputs of the corresponding subtraction devices; the first and the second inputs of these subtraction devices are, in turn, connected respectively to the first and the second output of the first and the second guidance device, while the input of the second guidance device is connected to the fifth output of the commutation unit; the first and the second output of the commutation unit are connected to the corresponding actuators, its third and fourth input are connected to the corresponding outputs of the first guidance device, while the fifth and the sixth input respectively to the third and the fourth output of the second guidance device.

14. The system for lighting of an object in accordance with claim 13 distinguished by the following: a commutation unit, which includes the first and the second commutator, the first radio receiver, a three-contact four-position radio-controlled switch, the first source of unit voltage, the first "I" element, the first inverter and a radio transmitter; the first and the third inputs of the first and the second commutator are, at the same time, respectively the first - fourth inputs of the commutation unit; the first and the third output of the commutation unit by a radio-controlled switch are connected to the output of the first commutator, the second and the fourth output - to the output of the second commutator, the fifth output, with the switch in the third position, - to the output of the unit voltage source; besides, the second and the third contact of the switch in the second - fourth positions of the switch are paralleled; in the third position the output of the unit voltage source is connected to the paralleled second inputs of the first and the second commutator; meantime, the first - sixth input of the "I" element are connected to the corresponding first - sixth input of the commutation unit, while the output of the "I" element is connected through the inverter to the radio transmitter.

15. The system for lighting of an object in accordance with claim 13 distinguished by the following: the first (third) guidance device has the first target seeker, the fifth and the

sixth actuators, the first and the second angular position pickup, kinematically connected with each other; inputs of the angular position pickups serve, at the same time, as the corresponding first and second output of the guidance device, which, in addition, has the first search signal conditioner and the third and the fourth commutator; the first outputs of these commutators are connected respectively to the first and the second output of the target seeker, whose first, second and third output is connected to the corresponding inputs of the search signal conditioner; the first and the second output of the search signal conditioner are connected to the third inputs, while its third output - to the paralleled second inputs of the third and the fourth commutator, the outputs of which, are, in turn, connected to the corresponding inputs of the fifth and the sixth actuators.

16. The system for lighting of an object in accordance with claim 13 distinguished by the following: the second guidance device has a target seeker equipped with a light marker (or a corner reflector), the seventh and the eighth actuators, the third and the fourth angular position pickups, whose outputs are at the same time the first and the second output of the guidance device, the fifth - eleventh commutators and the second search signal conditioner; the first inputs of the fifth, sixth and seventh commutator are connected to the corresponding first, second and third output of the target seeker, while the third

inputs to the corresponding fourth, fifth and sixth output of the second target seeker; the first and the second output of the target seeker serve, at the same time, as the third and the fourth output of the guidance device; besides, the second inputs of the abovementioned commutators are paralleled with the second inputs of the tenth and the eleventh commutator and serve as the commutation input of the guidance device, while the outputs of the fifth, sixth and seventh commutator are connected respectively to the first, second and third input of the second search signal conditioner, whose first and second output are connected respectively to the third inputs of the eighth and the ninth commutator; the second inputs of these commutators are paralleled and connected to the third output of the second search signal conditioner, with the first inputs of the eighth and the ninth commutator connected respectively to the outputs of the tenth and the eleventh commutator, the first inputs of which are connected to the first and the second output of the second target seeker, while their third inputs are connected respectively to its fourth and the fifth output.

17. The system for lighting of an object in accordance with claim 16 distinguished by the following: a laser installed in the third guidance device serves a source of radiation; the laser is connected to the laser excitation circuit, the first and the second input of which are connected to the third and the fourth output of the third guidance device.

18. The system for lighting of an object in accordance with claim 17 distinguished by the following: the laser excitation circuit includes the second radio receiver, a remote switch, connected to the second source of the unit signal, and connected in series the second element "I", an inverter and the third element "I_8", the second input of which is connected through the remote switch to the source of unit voltage, while its output is at the same time the output of the third "I" element; besides, the first and the second input of the second "I" element serve at the same time as inputs of the excitation system and are connected respectively to the third and the fourth output of the third guidance system.

19. The system for lighting of an object in accordance with claim 15 distinguished by the following: the search signal conditioner includes a logical unit, the output of which is connected to the reset input of a linearly changing generator and to the paralleled record permitting inputs of the first and the second storage sampling device; the outputs and information inputs of the storage sampling devices are connected respectively to the first inputs and outputs of the first and the second summer; the second inputs of the summers are connected respectively to the outputs of the first and the second modulators, whose first inputs are paralleled and connected to the output of the linearly changing voltage generator; the second inputs of the first and the second modulators are connected respectively to the first and second output of the quadrature

oscillator; besides, outputs of the first and the second summer are connected respectively to the inputs of the first and second analog-to-digital converter, while inputs and the output of the logical unit together with outputs of the analog-to-digital converters are respectively the inputs and outputs of the controlling signal conditioner.

20. The system for lighting of an object in accordance with claim 13 distinguished by the following: the first guidance device, optically bound with an object, is equipped with the first target seeker kinematically attached through the first and the second bracket to the fifth and the sixth actuators and respectively to the first and the second angular position pickup; the second guidance device, optically bound with the source of radiation, includes the second target seeker, kinematically attached through the third and the fourth bracket with the seventh and the eighth actuators and the third and the fourth angular position pickup; the first mirror kinematically attached to the first actuators is fixed on the internal frame of the first gimbal mount, the external frame of which is kinematically attached to the second actuators; the system also includes the second gimbal mount, which consists of the internal and external frame kinematically bound respectively to the third and the fourth actuators; the external frame of the second gimbal mount is joined to the concentric ring, on which the second mirror is fixed.

21. The system for lighting of an object in accordance with claim 13 distinguished by the following: the second mirror is made in the form of two rings concentric on the outer ring of the gimbal mount and on the attached to it the internal and external pneumatic chamber pneumatically joined by radial tubes to each other and to the source of compressed gas (air); the pneumatic chambers and the radial tubes are connected with a reflecting sheet, which consists of an elastic dielectric film, coated with a light reflecting metal cover (e.g., aluminium).

22. The system for lighting of an object in accordance with claim 21 distinguished by the following: the second mirror has an additional second reflecting sheet, which is adjusted at a fixed distance from the first one, with the metal layers of the sheets connected to the opposite poles of the re-introduced emf source.

23. The system for lighting of an object in accordance with claim 20 distinguished by the following: the first and the second reflecting sheet together with the internal and external pneumatic chamber create a hermetically sealed cavity of reduced pressure attached to a re-introduced source of vacuum.

24. The system for lighting of an object in accordance with claim 22 distinguished by the following: the internal pneumatic chamber consists of two pneumatically integrated sections joined by a corrugated elastic band in order they could move relative to each other; the metal coating of the second reflecting sheet is

made in the form of concentric rings isolated from each other and connected to different controlled voltage sources.--

REMARKS

By this Preliminary Amendment, the application has been amended to conform with U.S. practice, the cross-reference to related applications has been inserted on page 1 and Items 1-12 (claims 1-12) have been canceled and replaced with new claims 13-24. No new matter has been introduced. Entry of this amendment is respectfully requested.

Respectfully submitted,
ABDULLA ALIEV ET AL. (PCT)

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Lisa L. Vulpis

(12) МЕЖДУНАРОДНАЯ ЗАЯВКА, ОПУБЛИКОВАННАЯ В СООТВЕТСТВИИ С ДОГОВОРОМ О ПАТЕНТНОЙ КООПЕРАЦИИ (РСТ)

(19) ВСЕМИРНАЯ ОРГАНИЗАЦИЯ ИНТЕЛЛЕКТУАЛЬНОЙ СОБСТВЕННОСТИ
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(81) Указанные государства *(национально)*: CA, CN, DE, ES, GB, IL, JP, KR, RU, US.

Опубликована
С отчётом о международном поиске..

В отношении двухбуквенных кодов, кодов языков и других сокращений см. «Пояснения к кодам и сокращениям», публикуемые в начале каждого очередного выпуска Бюллетеня PCT.

WO 00/75679 A1

(54) Title: SYSTEM FOR ILLUMINATING AN OBJECT

(54) Название изобретения: СИСТЕМА ДЛЯ ПОДСВЕТА ОБЪЕКТА

(57) Abstract: The present invention pertains to the field of opto-electronic systems for the automatic following of moving objects and essentially relates to a system for illuminating objects. In order to search for a terrestrial target and to illuminate the same from outer space, the device of the present invention includes a switching unit as well as two tracking devices connected to a subtraction amplifier. The latter is connected to the inputs of corresponding executing organs which are cinematically connected to a first and a second mirror. The first tracking device is optically connected to the object while the second tracking device is optically connected to a radiation source.

[Продолжение на след. странице]

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G01C21/24
G01S3/789

9|PRTS

A system for lighting of an object

The invention deals with navigational engineering, specifically, optical-electronic systems for autotracking of moving objects.

There are systems for automatic guidance and tracking of moving targets, which are based on the frequency, phase, pulse-height, time-pulse and amplitude-phase principles and can be used for illumination of objects [1].

Known coordinators (target seekers) generate signals, which are proportional to the constituents of the angle of misalignment in two mutually perpendicular planes of control. These signals go to the monitoring drive of the system for target autotracking, which keeps the coordinator's optical system operating in a mode to have the optic axis constantly directed towards a target.

One of the reasons that prevent from obtaining the undermentioned technical result by the known device is the fact that modulation of the radiant flux is performed mechanically with the help of a modulating disk which is disposed in the focal plane of a lens and rotated by an electric motor with a constant speed.

There also exists a two-gimbal suspension with a diverting mirror for a precision optical tracking system developed by the **TRW** firm and intended to be used as part of an optical tracking system [2].

This device consists of a gimbal joint of flexible suspension, four electrodynamic drives, a caging gear, a device of signal levelling for integration with a capacitive pickup of the shift, and an electronic unit. A capacitive sensor serves for generating signals of angular misalignment along two axes.

On both sides of the outer gimbal ring there are two actuators of the detention system.

Mobile electromechanical clusters cause low reliability and low-speed response of the above-mentioned coordinators.

Besides, their construction does not allow directing mirror-reflected beams along their optic axes and, moreover, these target seekers are capable of tracing targets only within the immediate field of their vision and stop operating when the target is not seen, for they are not designed for operating in the search mode.

The nearest device of the same intent as the presentational invention in what concerns the complex of its characteristics is a system for location of two-dimensional coordinates of an object (a target seeker) [3]. The prototype has the first and the second ruled optical-electronic converter (OEC) with the image-transforming optics; the inputs of these converters are connected to the output of the synchro generator, while their outputs - to the inputs of the corresponding search signal detectors (threshold elements).

The ruled OECs are mutually perpendicular, so that rotation axes of the objects should pass through optical centres of the cylinder lenses L1 and L2.

On mutual lag (misalignment) of the strobe pulse and the target signal, control signal conditioners CSC1 and CSC2 produce control signals, whose signs and values are proportional to the angular coordinates of the target in two mutually perpendicular planes of control.

Yet, the known optical-electronic target seeker does not permit to point the beam at an object and seek for a target if the object is beyond its field of vision.

The purpose of the presentational invention consists in diversifying functions of a target seeker by enabling it to search for a ground target and to light it from the outer space.

The implementation of this invention will technically result in more precise measuring of angular coordinates of a target because now the beam is pointed at the centre of the target image.

This technical result is achieved with the help of such elements installed in the first device of the object guidance, as the additional second guidance device

optically connected with the source of radiation, the first and the second subtracting amplifier, the first and the second actuator and a mirror. The first outputs of the first and the second guidance device are connected to the corresponding inputs of the first subtracting amplifier, while their second outputs - to the corresponding inputs of the second subtracting amplifier. The outputs of the first and the second subtracting amplifier are connected to the inputs of the corresponding actuators kinematically linked to the mirror.

The first and the third guidance device are of identical circuit design and actuate electrically linked to each other the target seeker (TS), the search signal conditioner (SSC), the first and the second angular position pickup (APP_1, APP_2), commutators, the third and the fourth actuator (A_3, A_4), kinematically linked with a target seeker, and the angular position pickups.

Figure 1 shows the block diagram of the lighting system where:

1 - object;

2 - radiation source;

3, 4 - (1, 2 respectively) guidance device;

5, 6 - (1, 2 respectively) subtracting amplifier;

7, 8 - (1, 2 respectively) actuators;

9 - the first mirror;

$\tilde{n}$ - normal to the surface of the mirror 9 in the origin of the coordinate system OXYZ;

9^1 - the second mirror;

10 - commutation unit;

11, 12 - (3, 4 respectively) actuators;

13 - the third guidance device (GD_3);

14 - laser excitation circuit.

Figure 2 shows the functional diagram of the commutation unit (CU10) where:

15, 16 - (1, 2 respectively) commutators;

17 - the first radio receiver with an aerial (Ar);

18 - three-contact four-position radio-controlled switch;

19 - source of unit voltage $+V_1$;

20 - the first "I_1" element;

21 - the first inverter;

22 - radio transmitter;

V_{inp1}, V_{outp2} - the first and the second output;

V_3, V_4, V_3^{I}, V_4^{II} - the third - sixth input;

A_1, A_2, A_3, A_4 $+V_1$ - the first-fifth respective commutation unit output.

Figure 3 shows the block diagram of the first (third) guidance device (3,13) where:

23^{I} - the first (third) target seeker TS_1;

24 - the first (third) light marker (corner-reflector) LM_1^{I} (LM_1^{III});

25, 26 - (5,6 respectively) actuators A_5^{I}, A_6^{I}, A_5^{III}, A_6^{III});

27, 28 - (1, 2 respectively) angular position pickups;

29, 30 - (3, 4 respectively) commutators (C_3^{I}, C_4^{I}, C_3^{III}, C_4^{III});

31 – the first (third) search signal conditioner (SSC).

Figure 4 shows the block diagram of the second guidance device $GD_2$4, where:

32 - the second target seeker TS_2;

33 - the second light marker LM_2 (the second corner-reflector CR_2);

34, 35 - (7, 8 respectively) actuators (A_7, A_8);

36, 37 - (3, 4 respectively) angular position pickups (APP_3, APP_4);

38, 39, 40, 41, 42, 43, 44 (5, 6, 7, 8, 9, 10,11 respectively) - commutators;

45 - the second search signal conditioner (SSC_2);

46 - commutation input of the second guidance device (GD_2).

Figure 5 shows the pulse laser excitation circuit 14, where:

47 - the second radio receiver;

48 - remote radio-controlled switch;

49 - the second source of unit voltage $+V_2$;

50 - the excitation circuit output;

51 - the second "I_2" element;

52 - the second inverter (HE_2);

53 - the third "I_3" element.

Figure 6 shows the construction of the second film mirror 9^I, where:

54 - locating ring with limiters;

55 - internal pneumatic chamber consisting of 2 sections;

56 - external pneumatic chamber;

57 - radial tubes (hoses);

58 - the first elastic reflecting sheet;

59 - dielectric film;

60 - metal layer;

61 - source of compressed gas (SCG);

62 - the second elastic reflecting sheet;

63 - source of vacuum (pump);

64 - emf source;

65 - isolated rings;

66 - sources of controlled voltage;

67 - corrugated elastic band;

68 - the third pneumatic chamber;

69 - hose (gas conduit);

70 - clamp-shaped spring;

71 - valves.

Figure 7 shows combined kinematic and optical schemes of the system, in which the first target seeker $(TS_1)23^1$ of the first guidance device GD_13 makes the search of an object 1 with the help of the first 72 and the second 73 bracket of the actuators A_5 and A_6 (servomotors 25^1, 26^1), whose angular positions are determined by angular position pickups (APP^1 and APP^2) (synchro transmitters or

potentiometers) 27' and 28'. The second target seeker 23^{11} of the second guidance device is directed towards the source of radiation (the Sun) by the third 74 and the fourth 75 bracket, mechanically attached to the corresponding shafts of the actuators $A_7$34 and $A_8$35 (servomotors), whose angular positions are determined with the help of the third (APP_3 36) and the fourth (APP_4 37) angular position pickup of the second guidance device 4.

The second mirror 9^I is established on the gimbal mount, which consists of an internal 76 and external 77 frame.

The second mirror 9^I is rigidly fixed on the ring 54, which, in its turn, is rigidly attached to the external frame of the gimbal mount 77, whose position with respect to the internal frame 76 is changed with the help of the third actuators A_3 (the servomotor) 11. Position of the internal frame 76 with respect to a gyro-stabilised platform is changed with the help of the fourth actuators A_4 12.

Figure 8 shows different positions of the mirror ($\varphi_1 \div \varphi_6$) rotating about its axis in relation to the Earth 78.

Figure 9 shows the functional flow chart of the searching signals conditioners (SSC_1 31, SSC_2 65), where 79 is a generator of linearly changing voltage (GLCV), whose output is connected to the controlling inputs of the first 80 and the second 81 amplitude modulator (M_1, M_2). The modulators' outputs are connected to the first inputs respectively of the first 82 and the second 83 summer (E_1, E_2). The second inputs of the summers, in their turn, are connected to the outputs respectively of the first 84 and the second 85 storage sampling device (SSD_1, SSD_2), while their outputs – to the inputs respectively of the first 86 and the second 87 analogue-digital converter (ADC_1, ADC_2). 88 is a quadrature generator (G); 89 - a logical unit (LU), the inputs of which are respectively the first 90, the second 91 and the sync input 92 of the search signal conditioner $SSC_1$31, $SSC_2$45, while 93 and 94 are respectively its first and second output.

Figure 10 gives the functional diagram of the logical unit 89, where 90, 91, and 92 are the first, the second and the sync input; 95 and 96 - the first and the

second inverter (HE_3, HE_4), whose outputs are connected respectively to the setting to unity sync inputs of the first 97 and the second 98 flip-flop, with their outputs connected to the D-inputs of the corresponding third 99 and fourth 100 flip-flop; their outputs, in turn, are connected to the inputs of the fourth "I" element 101; C-inputs of the first two flip-flops (FF_1, FF_2) are paralleled and connected to the output of the fourth inverter 102. The fourth "I" 101 element's output is the output 103 of the logical unit 89.

The system for lighting of an object operates as follows.

For illumination of cities situated in the area of middle latitudes and at the equator, the system for illumination should be installed on a gyrostabilised platform placed in a stationary orbit with an altitude about 36,000 km. Fixity of the satellite, which is carrying the system of the mirror guidance, in relation to the ground object adds to the advantages of the project.

High altitude of the stationary orbit permits to light a number of selected ground objects with the help of a single system.

From a satellite in the stationary orbit a vast area of the Earth can be seen that extends for $\pm 60^0$ from the west to the east and for $\pm 70^0$ from the north to the south.

Emergency illumination of objects in case of natural disasters and catastrophes is secured by three systems, which are removed from each other for 120^0 along the equator and completely embrace the Earth surface, except for the polar areas.

A satellite in the stationary orbit is almost constantly illuminated by the Sun. Its stay in the Earth shadow takes not more than 1% of the earth-rotation period, which determines high potency of the system.

While tracking, the mirror turns through 45^0 in 6 hours, that is, it rotates at the angular velocity of $\varphi' = 7.5$ '/min (minutes of arc per minute).

The whole system can be supplied with power by solar batteries, which are permanently directed towards the Sun by the second guidance device GD_2 4.

Directing sensors usually consist of two sensing elements, electrically linked into a bridge circuit. Together with them, the system of solar orientation includes an all-round looking sensor to produce information to a low degree of accuracy sufficient for more precise sensors of the guiding device 4 to direct their fields of vision towards the Sun.

The system for lighting of an object is established on a gyrostabilised platform of a space vehicle (SV). Every problem of the SV flight control is handled by the control system. Together with the problem of an SV attitude-control and stabilisation, it is guidance of the GD_1 and GD_2 towards different objects in response to a command from the Earth.

Signals, qualifying physical parameters of the flight, are received from the system of sensors.

Sensors of direction are used for attitude control. Stabilisation of the SV is performed by signals from the sensors of direction and by signals of gyroscopic pickups, which register position of the axes in space.

Reference parameters of the SV flight can be loaded into the storage of an onboard computer, transmitted aboard by the ground stations through a command radio line or withdrawn from the pickups of the gyro-stabilised platform.

Comparison of actual flight parameters with the reference ones, detection of error signals and generating of correcting control signals are performed by an onboard computer.

The second mirror 9^I is rotated about two orthogonally related axes OX and OY with the help of the actuators A_3 11 and A_4 12. A change in the attitude of the locating ring 54 is followed by the change in the attitude of the second mirror. The external frame of the ring-shaped gimbal mount 77 is fit with the locating ring with limiters 54 and the internal pneumatic chamber 55. This chamber is pneumatically connected by radial tubes (hoses) 57 with the concentric external pneumatic chamber 56 and together with it makes a single pressure-tight cavity, which is jointed up to a source of compressed gas (SCG) 61. In transit, the chamber is empty

and may be folded. Gas delivery will make the chamber take the form of a wheel. The external ring 56 can be a few tens of kilometres in radius. In advance, when still on the ground, the reflecting sheet 58 is attached to the pneumatic chambers 55, 56. With gas delivery from the source SCG 61, the external ring 56 starts pulling the first reflecting sheet 58. The pneumatic chambers finally having taken the form of the wheel, the reflecting sheet 58 should take the form of a plane.

For attainment of strength, the sheet can have a kapron warp coated with a dielectric film (e.g., fluorine plastic), on which a reflecting metal coating 60 (e.g., aluminium) is applied.

When filled with gas, the collapsible radical hoses 57 take the form of tubes. They, to some extent, reinforce the pneumatic wheel (see Fig. 6). This is how the second mirror 9^I is constructed. With the help of the third 11 and the fourth 12 actuators the second mirror 9^I is rotated about the axes OX and OY to direct the reflected sunrays towards a ground object.

Because the solar disk has a Ψ angle of view, rays reflected by the mirror 9^I diverge and illuminate the ground area considerably exceeding that of the mirror.

The second mirror 9^I may be given a spherical (concave) form. This allows to concentrate sunrays on a small area and, thus, to increase the illuminance. For the purposes of defence, the focused sunrays can be used for setting fire to the enemy's ground objects. For peaceful purposes, energy of radiation can be transformed into electrical energy with the help of solar batteries. If necessary, a spot beam following a spiral or any other prescribed trajectory, which depends on the voltage values generated by the quadrature generator 45 (Fig. 6), can intensify illumination of the surface like a floodlight.

To obtain a spherical specular surface (see Fig.6), in addition to the first reflecting sheet 58 the second reflecting sheet 62 is used. Both reflecting sheets 58 and 62 are attached only to the pneumatic chambers 55, 56. They are not joined to radial tubes. The internal 55 and external 56 pneumatic chambers together with the reflecting sheets 58, 62 make a sealed chamber, which is joined to the source of

vacuum (vacuum pump) 63. Pressure created by the source of vacuum between the reflecting sheets in the chamber is lower, than that in the ambient outer space. Due to exuberant external pressure, the specular sheets are attracted to each other and their surface receives the spherical form. The sag value ***h*** can be calculated beforehand and taken into account when fixing the sheets to the internal pneumatic chamber 55. The inner edges of the sheets are brought together relative to the plane for a distance of 2h. If necessary, this spacing interval can also be changed within 0÷2h by a remote command from the Earth.

Electrostatic forces can be used to obtain a spherical specular surface and for remote modification of its radius of curvature.

For this purpose, the metal platings of the reflecting sheets 58, 62 are connected to the emf source (or voltage) 65. By varying the voltage, it is possible to control the force of electrostatic attraction of the sheets, and by this to perform remote focusing of the 9^1 mirror and to control focusing of the luminous flux.

To create a spherical mirror, electrostatic forces and excessive external pressure can be simultaneously applied as well.

Employment of both specular surfaces is also possible, for which it is necessary to turn them through 180^0.

In order a flat mirror could be transformed into a spherical one, the internal pneumatic chamber 55 should be made of two sections pneumatically attached to each other by a corrugated elastic band 67. The third pneumatic chamber 68 joined to the source of compressed gas 61 by a separate gas line (hose) 69 is installed inside this corrugated band. By varying pressure in the third pneumatic chamber we can remotely change the interval between two sections of the internal pneumatic chamber within the limits from 0 to 2h. This is how the sag of the second mirror's spherical surface and the radius of its curvature are changed.

At Fig. 5 the corrugated band is topped with a yoke-shaped spring 70, but it is possible for the band itself to work as a spring.

In the normal position, both sections of the internal chamber are pressed to each other. With the start of gas delivery into the third pneumatic chamber 68 inserted into the corrugated elastic band 67, sections of the internal pneumatic chamber 55 move apart. At definite pressure specular sheets 58, 62 take the form of a plane. To prevent from the further recession, there must be limiters fixed on both sides. A locating ring with end arresters 54 serves this purpose.

To give the specular surface of the sheet a regular spherical form, the second metal coating applied on the second reflecting sheet 62 has the form of concentric rings 55. Each ring has an electrical outlet soldered to the metal bed.

By selecting the quantity, bandwidth and voltage applied to each ring, as well as the pressure in the third pneumatic chamber 68, we can create specular surfaces of any configuration and curvature.

Depending on the problem to be decided, the on-board computer by the ground command will change the voltage Vi on rings 65 and pressure in the pneumatic chamber 68.

For more effective employment of the system, in the daytime the second large-size mirror can be used for a radio, television and telephone communication between ground objects. The mirror is used as a passive reflector. It is automatically established in the position that the normal ñ to the centre of the mirror should coincide with the "mirror - radio beacon" direction. In this case, the maximum of the directivity lobe of the transmitting antenna is pointed at the mirror. The system works more effectively if the transmitter has a narrow directivity lobe, as that for laser-beam communication. Radiation of the transmitter falls on the mirror and, having been reflected by it, returns to the Earth. Owing to angular divergence of the transmitter's radiation, radiation reflected by the mirror covers a greater area. With a corner reflector placed in front of the target seeker TS_1 and the transmitter installed on a satellite-tracking platform, the beam can be confined to several minutes of arc. Thus, the system can be used for laser beam communication between two ground objects, for which the second target seeker TS_2 must keep

tracking the second ground object. To achieve this purpose, the second seeker TS_2 in addition to an optical sensor is equipped by radio-frequency range sensors designed similarly to those of the first seeker TS_1.

In order to establish a directional two-way laser beam communication between two ground objects, both transmitters should be installed on tracking platforms, with their radiation directed towards corner reflectors placed in front of the corresponding target seekers TS_1 and TS_2. Within the frequency range the transmitters should operate at different frequencies to exclude interference.

Changing between operational modes of the system is done in response to the ground commands delivered through a radio circuit. For this, the system is equipped with a commutation unit CU, with the help of which the system is placed in one of four operational modes:

a) directing the laser beam towards a target with the help of the first mirror (the I position of the switch 18);
b) one- or two-way communication between two ground objects with the help of the mirror 9^1 (the II position);
c) illumination of a ground object by radiation of its own transmitter (the III position) reflected by the mirror 9^1;
d) illumination of a ground object by the solar radiation with the help of the second mirror 9^1 (the IV position).

For exploiting the system in the "**a**" mode, a radio beacon should be placed in the centre of a lighted ground object (a city). To reduce power of the radio beacon, the latter can be installed on a guidance device designed as $GD_1 3$ (see Fig.3).

The first guidance device $GD_1 3$ is tracking the radio beacon 1, while the second guidance device GD_2 4 is intended for tracking the solar disk.

These guidance devices 3 and 4 (see Fig.3) permanently keep the radio beacon and the centre of the solar disk on the optic axes of the corresponding target seekers TS_1 and TS_2.

Two signals, proportional to angular coordinates of the target ΔV_α and ΔV_β in two planes of control are shaped at the outputs of the guidance devices.

These signals go to the inputs of the corresponding subtracting amplifiers SA_1 5 and SA_2 6. The subtracting amplifiers compare coming signals and generate difference signals $\pm\alpha=\Delta V_{\alpha 1}-\Delta V_{\alpha 2}$ and $\pm\beta=\Delta V_{\beta 1}-\Delta V_{\beta 2}$. These difference signals go respectively to the first and the second input of the commutation unit CU10.

The third and the fourth input of the commutation unit are connected to the corresponding outputs of the first guidance device 3. The fifth and the sixth input of the commutation unit are connected respectively to the third and the fourth output of the second guidance device. It is done in the way that the first, second, third and fourth output of the commutation unit are connected to the inputs of the corresponding actuators $A_1$7, $A_2$8, $A_3$11 and $A_4$12. The fifth output of the commutation unit is connected to the output of the second guidance device 4.

In the "**b**" mode the third A_3 and the fourth A_4 actuators are kinematically connected with the second mirror 9^1. The second mirror 9^I is used for aiming solar rays at a ground object (a city) in night-time. The same mirror can be used as a passive reflector for communication between any two ground objects and for radiotelephone space communication in mountain areas. In this case, the second mirror 9^1 is automatically set perpendicularly to the optic axis of the first guidance device GD_1, which keeps tracking the radio beacon 1 placed in the centre of a lighted ground object (a city).

In the "**c**" mode the first and the second actuators are kinematically connected with the first mirror 9. This small-size mirror is placed in the centre of the coordinates, so that the **0** point should coincide with the centre of the mirror, and is used for aiming of a high-power laser beam. This mirror is made of beryllium bronze and cooled by liquid helium.

In the "**d**" mode of directing a laser beam towards an enemy's target, the latter is used as an object. The second guidance device GD_2 is aimed at the laser (radiation source 2). On the third guidance device $GD_3$13 there is a laser, which

may be given the form of a cylinder whose axis (radiation) coincides with the optic axis of the guidance device GD3 target seeker. A light marker or a radio beacon, which is coaxially placed in front of the laser so that the latter might be better distinguished against the ground surface, determines employment of optical or radar sensors (transducers) of the second target seeker TS_2. The first, second and third output are the outputs of the radar sensor, while the fourth, fifth and sixth ones are the outputs of the optical sensor.

By the ground command the radio receiver 17 (Fig.2) with an aerial Ar shifts a three-contact switch to one of the four positions (I, II, III, IV). Depending on the position of the switch, actuators A_1, A_2, A_3 and A_4 receive signals from the outputs of the subtracting amplifiers or from the third and the fourth output of the first guidance device 3. Besides, the switch 18 connects the commutation output of the LU 10 with the output of the source of a unit signal ($+V_1$) 19 (position IV).

The switch 18 in the upper (I) position, the system works in the "**a**" mode. The outputs of the subtracting amplifiers 5 and 6 through commutators 15, 16, are connected respectively to the inputs of the first and the second actuators 7 and 8. The system controls the central first metal mirror 9.

In this case, at the output of the commutation unit 10 there appears a unit signal $+V_1$, which goes to the commutation input of the second guidance device GD_2 4.

In this case the system is used for aiming a powerful laser beam at the target. The source of radiation 2 (a laser) is installed on the third guidance device GD_3 13. By reducing control signals to zero in 2 planes, the third guidance device 13 aims the laser at the light marker (or a corner reflector), placed in front of the target seeker of the second guidance device GD_2.

The second guidance device, in its turn, is aimed at a light marker (a radio beacon) placed in front of the laser 2. When the output signals from the target seekers of the second 4 and the third 13 guidance device become zero, their optic axes coincide, and the laser beam hits Point O. After the error has been minimized,

the optic axis of the target seeker TS_1 of the first guidance device GD_1 4 comes to coincide with the direction "O – an object". Difference signals from the outputs of the subtracting amplifiers having been reduced to zero by the actuators $A_1$7 and $A_2$8, the first mirror takes the following position: the normal $\bar{n}$ in the Point O (origin of the coordinates) becomes a bisectrix of the angle between optic axes of the target seekers of the first and the second guidance device 3 and 4. The incident laser beam, having been reflected by the first mirror 9, hits the target 1.

To start a giant-pulse laser, an excitation pulse should be applied at the moment when the output signals of all target seekers of guidance devices TS_1, TS_2, TS_3 3, 4, 13 and of the subtracting amplifiers 5 and 6 come to zero. The outputs of the subtracting amplifiers should be connected to the "I_1" element 20 provided with the inverter HE1 21. A unit signal from the output of the inverter starts the laser. Information about zero values of the signal at the outputs of target seekers and subtracting amplifiers may be transmitted through radio or laser commutation.

The middle position (II) of the switch corresponds to zero value of the signal at the second inputs of the first 15 and the second 16 commutator. In this case, the outputs of subtracting amplifiers are switched to the inputs of the third A_3 and the fourth A_4 actuators, i.e. the system controls the second film mirror 9^I.

The second and the third contact of the switch 18 connect outputs of the commutators 15 and 16 with the inputs of the third and the fourth actuators. These actuators minimize error signals coming to the first inputs of commutators 15 and 16 from the outputs of subtracting amplifiers SA_1 5 and SA_2 6. By turning the second film mirror 9^I, the system can provide space communication between two ground objects, which have to be equipped with radio beacons. The first guidance device 3 is pointed to the object (radio beacon) 1, while the second guidance device 4 – to the second radio beacon. The second mirror 9^I is automatically adjusted in such a way that a beam, radio-frequency radiation in the VHF or microwave range or a laser beam after having been reflected by the metal coating of the mirror 9 hits the second ground object and vice versa. With a view to secrecy the first (small)

mirror 9 can be used. This is how the space communication between two ground objects can be carried out.

With the switch 18 in the third (III) position, the unit signal $+V_1$ from the source output goes to the second inputs of the first and the second commutator 15, 16 and makes them pass the signals from the third (V_3) and the fourth (V_4) output of the first guidance device GD_1 3. to the output of the commutation unit. These signals from the first and the second output of the target seeker TS_1 of the first guidance device GD_1 go to the inputs of the third and the fourth actuators which follow to indicate them. In this case the second mirror 9^I becomes perpendicular to the optic axis of the first guidance device GD_1 directed towards the radio beacon 1.

With the radio-controlled switch 19 in the fourth (IV) position, the system works in the "**d**" mode. In this case, the unit voltage $+V_1$ from the output of the unit 18 goes to the fifth output of the commutation unit 10. This output is connected to the input of the second guidance device GD_2 4.

The fourth operation mode "**d**" demands that the second guidance device 4 should have a target seeker TS_2 32 (see Fig.4) with the sensors working within both the optical range (outputs 1,2,3), and the radio frequency band (outputs 4, 5, 6).

In comparison with the first 3 and the third 13 guidance device (see Fig.3), the second guidance device GD_2 4 (see Fig.4) has the additional fifth, sixth, seventh, eighth and ninth commutator. With no unit signal at the commutation input 37, the first, second and third output of the target seeker are connected to the corresponding inputs of the search signal conditioner 31 through commutators 32, 33 and 34. Besides, the first and the second output of the target seeker 23 are connected to the first inputs of the third 29 and the fourth 30 commutator through the eighth 35 and the ninth 36 commutator.

With the zero signal at the second inputs of these commutators (29 and 30), the first and the second output of the $TS_3$23 are connected respectively to the inputs of the fifth 25 and the sixth 26 actuator. Thus, with a zero signal at the

commutation input of the third guidance device 4, it works in the same way as the first 3 and the third 13 guidance device (see Fig.3).

In the lower position of the radio-controlled switch 18 a unit signal $+V_1$ goes to the commutation input 46 of the second guidance device 4.

In this case, the fifth, sixth and seventh commutator 38, 39, 40 let signals from the corresponding fourth, fifth and sixth output of the TS_2 32 pass to the input of the search signal conditioner (SSC_2) 45.

At the same time, the tenth 43 and the eleventh 44 commutator let signals from the fourth and the fifth output of the target seeker of the second guidance device 4 pass to the first inputs of the eighth 41 and the ninth 42 commutator (see Fig.3a).

In this case the radiosensors of the second target seeker 32 of the third guidance device GD_2 4 work.

Target seekers TS_1 23 of the first 3 (and the third 13) guidance device work in the radio-frequency range.

As for the rest, principles of operation of guidance devices 3, 4, and 13 coincide.

If it is necessary to work in the optical range, guidance devices of the GD_2 type can be used, with a unit signal $+V_1$ given to the commutation input.

The object 1 comes into the field of vision of the first guidance device GD_1 3. When the object does not coincide with the optic axis of the GD_1 target seeker, control signals at the TS_1 output are different from zero.

Difference signals from the TS_1 23 go to the fifth $A_5$25 and the sixth $A_6$26 actuators (servomotors) to be reproduced. The first 72 and the second 73 bracket together with the corresponding servomotors 25 and 26 turn the target seeker TS_1 about the axes OX and OY. The optic axis of the TS_1 is always directed towards the Point O, i.e. towards the centre of the sphere, on which the target seeker TS_1 23 moves. Difference signals from the TS_1 have been reproduced, the target seeker TS_1 23 takes such a position that its optic axis coincides with the direction towards

the object (radio beacon) 1. When a system for lighting of an object is established on a mobile object, e.g., onboard a flight vehicle, it should be placed on a gyro-stabilised platform in order to provide gyroscopic decoupling. Angular position of the first target seeker TS_1 23 with respect to the platform in two planes of control can be measured with the help of the first APP_1 27 and the second APP_2 28 angular position pickup (synchro transmitters or potentiometers).

For guiding a pencil-beam aerial of the automatic direction-tracking system ADT the method of radio direction finding is used [4].

In the radio-frequency range, ADT_1 and ADT_2 are used instead of target seekers TS_1 and TS_2.

A transmitting antenna of the radar station RS is placed in the centre of a lighted ground object (e.g., a city) and radiates electromagnetic waves into the ambient space. To reduce power of the radio automatic direction-tracking device (ADT), $TS_1$23 may be equipped with a corner reflector.

The corner reflector consists of three reflective plates adjusted perpendicularly to each other. In the corner reflector, incident energy from the radar station, having been two or three times reflected by surfaces of the three plates, is reverted in the direction the radiation has come from. Thus, a small-sized corner reflector is capable to create reflection of high intensity [4].

The transmitting aerial of the radar station with the help of an automatic direction-tracking device (ADT) is oriented to the corner reflector and points electromagnetic waves to it. The first automatic direction-tracking device (ADT_1), in turn, directs the axis of the first target seeker $TS_1$23 (which coincides with the equisignal direction of the ADT_1) towards the source of radiation - RS 1.

The automatic direction-tracking devices ADT_1 and ADT_1 3 can be designed to use the method of conical scanning of an aerial beam or the monopulse measuring of angular coordinates; the latter guarantees a higher degree of accuracy and permits to use both pulse and continuous energy radiation [4].

It is known that with the first method used, deviation of an object from an equisignal direction is accompanied by the maximum beam alternately coming nearer to the object or receding from it. Owing to this, impulses of return signals are modulated in amplitude with a conical-scan frequency of the beam, while modulation depth depends on the value of the error. The curve, which turns tops of reflected pulses, is an error signal. The initial phase of the envelope curve depends on how far the object deviates from the equisignal position in azimuth and angle of elevation. Automatic tracking lies in automatic rotating of the aerial axis until the error signal becomes zero. When error signals of the both ADT devices become zero, the equisignal lines of transmitting and receiving aerials come to coincide and the axis of the first target seeker TS_1 is now directed towards the radiating aerial of the RS 1.

The second target seeker TS_2 32 is directed towards the Sun with the help of the third 74 and the fourth 75 bracket and the corresponding seventh A_7 34 and the eighth A_8 35 actuators (servomotors) of the second guidance device $GD_2$4 kinematically attached to them. Angular position of the target seeker TS_2 in respect to the gyro-stabilised platform is measured by the third and the fourth angular position pickup 36 and 37. When TS_2 turns about the axes OX and OY, its own optic axis always goes through the origin of OXYZ coordinates.

CCD-rulers used in the target seeker for aiming at the Sun are not damaged if locally overlit and do not get out of order even at a thousandfold increase of a luminous flux in comparison with the flow of saturation. To increase noise immunity of the Sun seeker, CCD-rulers' lenses are additionally equipped with optical filters e.g., of the IRS-7 type, which transmit radiation only of the near-infra-red region, and with neutral filters, that diminish brightness of the solar disk image to required values.

Whichever position target seekers TS_1 and TS_2 moving on the surface of the sphere may take, their optical axes intercross in the centre of the O sphere.

The second mirror 9^{I} is installed on a gimbal mount. The gimbal mount, which consists of the internal 76 and the external 77 frame kinematically attached to the corresponding third A_3 11 and the fourth $A_4$12 actuators (servomotors 11 and 12), provides rotation of the mirror about the axes OY and OX.

To direct incident sun rays, which coincide with the optical axis of the TS_2, along the "O-target" line (coincident with the optic axis of the TS_1), subtracting amplifiers (comparators) $SA_1$5 and $SA_2$6 are used.

Inputs of the first subtracting amplifier SA_1 5 are connected to the outputs of the first GD_1 3 and the second GD_2 4 guidance device. In position I of the switch 18 the outputs of the first subtracting amplifier SA_1 are connected to the inputs of the first actuators A_1 11. The A_1 provides rotation of the first mirror 9 about the OY axis. The first and the second input of the second subtracting amplifier SA_2 6 are connected respectively to the second outputs of the first GD_1 and the second GD_2 guidance device. The output of the SA_2 is connected to the input of the second actuators A_2. The A_2 provides rotation of the mirror about the OX axis.

The subtracting amplifiers (comparators) 5 and 6 generate difference signals $\Delta U = U_1 - U_2$, where U_1 and U_2 are voltage values removed from two angular position pickups of the GD_1 and GD_2, (e.g., from potentiometers). Movable contacts of the potentiometers are kinematically attached to brackets, with the help of which the target seekers TS_1 and TS_2 are directed towards the object 1 and the radiation source 2. The subtracting amplifier is built around an operational amplifier. The difference signal ΔU at the output of the subtracting amplifier is proportional to the difference of the angles $\Delta\alpha$ (or $\Delta\beta$) in two planes of control (XOZ and YOZ). The difference signal $\pm\Delta U$ goes to the corresponding actuators A_1 11 and A_2 12, which follow to indicate them and rotate the mirror about the OX and OY axes in order to reduce error signals to zero.

With an object of the first target seeker TS_1 out of sight, the system goes into the search operation. In this case, the inputs of the fifth and the sixth actuators

through the third 29 and the fourth 30 commutators are connected to the outputs of the search signal conditioner SSC_1 31.

Similarly, with source of radiation 2 out of sight of the second target seeker 32 of the second guidance device GD_2 4, the inputs of the seventh 34 and the eighth 35 actuators are connected to the outputs of the SSC_2 45.

The search signal conditioners SSC_1 31 and SSC_2 45 of the guidance devices GD_1, GD_2 shape two signals of ramp amplitude in phase quadrature (sin φ, cos φ). Having received such signals, the actuators A_5 25' and A_6 26' (34 and 35) rotate TS_1 (TS_2) about the OX and OY axes so that the optic axes of the target seekers are scanned along the spiral sweep-trace.

When the Sun comes into the field of vision of the second target seeker, its radiation is registered with the help of optical-electronic transducers of the TS_2 32. So, its outputs send sync pulses from the outputs of the synchronizing signal generator to sync inputs of the 92 SSC, while the first 90 and the second 91 input of the SSC_2 receive normalized signals coming from the outputs of the target signal detectors. Having received the both signals from the outputs of the target signal detectors, the system goes into the tracking operation. Commutators 41, 42, 43, 44 connect inputs of the A_7 and A_8 to the target seeker TS_2 32 outputs of the GD_2.

The search signal conditioners (SSC_1) 31 and (SSC_2) 45 work as described below (see Fig. 9).

If there is no target pulse in the interval between two successive sync pulses (at least, at one of the SSC_1 information inputs), then at the output of the logical unit (LU) 103 there appears a level of the logical unit, which prevents recording new information in the devices of storage sampling DSS_1 84 and DSS_2 85 (operation of the logical set will be described below). At the moment of changeover at the LU 103 output from zero to one, that is along the leading edge, the voltage at the output of the GLCV (generator of linearly changing voltage) 79 steps down to zero and starts to increase linearly (from zero).

Output voltage of the GLCV modulates harmonic signals from the outputs of the quadrature generator 78 by means of modulators M_1 70 and M_2 71, with the signals at the generator 88 outputs 90-deg out of phase. This allows having harmonic signals of ramp amplitude in phase quadrature (sine and cosine) at the outputs of the amplitude modulators 80 and 81.

At the outputs of the first and the second summers 72 and 73 there appear voltage values equal to the sum of voltage values at the outputs of corresponding modulators 80 and 81 and DSS_1 84 and DSS_2 85, i.e., $U_{DSS1} + U_{M1} = U_{\Sigma1}$; where U_{DSS1}, U_{M1} and $U_{\Sigma1}$ are voltage values at the outputs of the DSS_1, modulator M_1 and the summer Σ_1.

Similarly to $U_{DSS2} + U_{M2} = U_{\Sigma2}$, the analog-to-digital converters ADC_1 86 and ADC_2 87 convert voltage at the outputs of corresponding summers 82 and 83 into a digital signal. If the SSC_1 and SSC_2 are required to produce analog-formed control signals, the analog-digital converters ADC_1 86 and ADC_2 87 are not necessary.

Space scanning can be achieved by application of the signal from the outputs of the summers 82 and 83 (by means of ADC_1 86 and ADC_2 87 ADC_2 87) to the fifth and the sixth (the seventh and the eighth) actuators of the guidance devices GD_1 (GD_2), which provide rotation of the TS_1 23 (TS_2 32) in two mutually perpendicular planes about the OX and OY axes of the OXOY coordinate system connected with the gyro-stabilised platform. Position taken by the start of the spiral depends on the voltage values at the outputs of the DSS_1 84 and DSS_2 85, i.e. these values are proportional to the tangents of the angular coordinates.

If a radio beacon or the Sun comes into the field of view of the target seeker TS_1 23 (TS_2 32), the radiation is recorded with the help of detectors or optical-electric converters. In this case, at the outputs of the target detectors TD there appear pulses of target detection [3], which will assure the level of logical zero at the output of the logical unit 103. At this moment, instantaneous (current) voltage values are recorded at the outputs of the corresponding summers 82 and 83 along

the trailing edge of the LU 89 output in the DSS_1 84 and DSS_2 85, and zero voltage is provided at the GLCV output. As long as the target is in the beam path, the logical set will shape "1", thus providing zero voltage at the GLCV 79 output, while at the output of the summers 82 and 83 voltage remains the same, since the DSS_1 84 and DSS_2 85 store the voltage values produced at the outputs of the summers 82 and 83 at the moment of "0" appearing at the LU 89 output (i.e. $U_{DSS1} = U_{\Sigma 1}$), and "0" at the GLCV output (i.e. $U_{M1} = 0$).

This is how the stationary position of the mirror 9 is obtained. When the target leaves the field of vision of the TS_1 23 or (TS_2 32), the level of the logical unit appears at the LU 89 output, the GLCV starts to produce ramp voltage, recording in the DSS_1 84 and DSS_2 85 is blocked and the process (spiral sweep) starts, the centre of the spiral being in the straight line, which crossed the target at the moment of its leaving the field of vision of the target seeker.

If there is no target in the field of view of the target seeker and the voltage at the GLCV output has reached some value assigned in advance and determined by the field of vision of the system, the GLCV resets the output voltage and the above-mentioned process starts anew.

The quadrature generator 88 can be designed as shown in Fig. 5.12., page 137 [7], the DSS as in Fig. 3.1., page 77 [7]. To prevent the DSS and the summers from inversion, they should be placed in series with invertors that have a unit gain factor 1 (see Fig. 1.8."c", page 18 [7]).

The analog-digital converter (ADC) can be realised in a circuit design shown in [6] (see Fig. 24, 23, page 458).

For modulators it is possible to use standard amplitude modulators, with their control inputs connected to the LU output and carrier frequency inputs to the corresponding outputs of the quadrature generator.

The GLCV may be built around a standard generator of the saw-tooth growing voltage type.

In the above-mentioned shaper it is possible to use chips of the K153UD2, K140UD7, K140UD8, K154UD2 type, insulated-gate field-effect transistors, capacitors with a small loss tangent, etc.

The logical unit 89 can be designed as shown in Fig. 7. It operates as described below.

A synchronising pulse, which has come to the input 91 through the inverter 102, sets the first 97 and the second 98 flip-flop to zero along the trailing edge, since K155TM2 chip flip-flops, which are used here, switch at the changeover from"0" to "1".

On the leading edge of the sync pulse, information from the above-mentioned flip-flops is copied into the third 99 and the fourth 100 flip-flop (these flip-flops are also based on the K155TM2 chips). The four flip-flops operate in this way because pulses that come to their sync inputs are out of phase.

The first 97 (or the second 98) flip-flop will be in the unit state given that within the current period between two successive sync pulses there is a circuit pulse from the corresponding target detector (TD) that comes to the input 90 (102). Otherwise, the flip-flop stays in the zero state. After arrival of the sync pulse, this information is copied into the third 99 (the fourth 100) flip-flop.

Thus, a logical unit appears at the direct input of the third 89 (the fourth 90) flip-flop on condition that within the given period between two successive sync pulses there is an object pulse from the corresponding target detector (TS) output; otherwise the signal takes the zero value.

The zero state of either of the two 99 and 100 flip-flops results in the level of a logical zero at the LU output. This is provided by the "I" element 91, which can be based on a K155LI1chip.

The inverters can be based on chips of the K155LN1 type.

In the systems for lighting of an object it is possible to use gyroscopic, electromechanical or electrohydraulic actuators. The first ones seem preferable, as they are inertialess [1]. In case the target seeker's axis deviates from the direction

required, correctional sensors, which are connected with the axes of the frames and receive signals, create torques that make the gyro precess in the direction of the object.

By measuring strength of current in windings of correlation sensors (the value of the moments) it is possible to determine projections of the angular velocity vector of the observing line on two mutually perpendicular directions [1]. Wapers of potentiometer transducers fixed on the rotation axes of the gimbal joint frames will help to determine angular coordinates in respect to the platform, on which the gyroscope is installed. In this case, sensor cases should be rigidly attached to the platform [1].

In electromechanical autotracking systems direct current engines [1] can be used as servomotors. Taking into account values and signs of output signals, servomotors correct misalignments between the target seekers' axes and the direction towards the object. Wapers of potentiometer transducers or synchro transmitters fixed on rotation axes of the frames of the coordination unit produce signals, which determine angular position of the target seekers in relation to the axis of the controlled object.

To obtain a signal proportional to angular velocity of the observing line, tachogenerators are used, kinematically attached to the shafts of servomotors. The same tachogenerators can be used as elements of vanishing feedback. Information about the angular position and angular velocity of the servo drive's observing line is used for control of an object. Signals proportional to the angular position of the coordinators are received from potentiometers or synchro transmitters fixed on the rotation axes of the gimbal mount frames, while signals proportional to the angular velocity of the observing line come from resistors inserted into the windings circuit of correction torque motors of the gyroscopic drive or from tachogenerators, kinematically attached to servomotors of the electromechanical drive.

In addition to automatic lighting of ground objects the system provides information about the angular position of the target in relation to the OZ-axis. For

this purpose, information about the angular position of a ground object is obtained from the outputs of the angular position pickups APP_1 27 and APP_2 28. The presentational system, in comparison with its prototype, allows automatic illumination of ground objects from space. It also permits to increase the accuracy of measuring angular coordinates of the target, since the beam is aimed at the centre of the target image.

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Formula of the invention

Item 1. The system for lighting of an object includes a source of radiation, the first guidance device optically integrated with an object, and the first mirror, kinematically bound with the first and the second actuators. The system is

distinguished by the additional second guidance device, the first and the second subtracting amplifier, a commutation unit, the third and the fourth actuators, and the second mirror, kinematically bound with the third and the fourth actuators. Inputs of these actuators are connected to the corresponding outputs of the commutation unit, whose first and second input are connected to the outputs of the corresponding subtraction devices. The first and the second inputs of these subtraction devices are, in turn, connected respectively to the first and the second output of the first and the second guidance device, while the input of the second guidance device is connected to the fifth output of the commutation unit. The first and the second output of the commutation unit are connected to the corresponding actuators, its third and fourth input are connected to the corresponding outputs of the first guidance device, while the fifth and the sixth input respectively to the third and the fourth output of the second guidance device.

Item 2. The system for lighting of an object in accordance with Item 1 distinguished by the following: a commutation unit, which includes the first and the second commutator, the first radio receiver, a three-contact four-position radio-controlled switch, the first source of unit voltage, the first "I" element, the first inverter and a radio transmitter. The first and the third inputs of the first and the second commutator are, at the same time, respectively the first - fourth inputs of the commutation unit. The first and the third output of the commutation unit by a radio-controlled switch are connected to the output of the first commutator, the second and the fourth output – to the output of the second commutator, the fifth output, with the switch in the third position, - to the output of the unit voltage source. Besides, the second and the third contact of the switch in the second-fourth positions of the switch are paralleled; in the third position the output of the unit volltage source is connected to the paralleled second inputs of the first and the second commutator. Meantime, the first - sixth input of the "I" element are connected to the corresponding first - sixth input of the commutation unit, while the output of the "I" element is connected through the inverter to the radio transmitter.

Item 3. The system for lighting of an object in accordance with Item 1 distinguished by the following: the first (third) guidance device has the first target seeker, the fifth and the sixth actuators, the first and the second angular position pickup, kinematically connected with each other. Inputs of the angular position pickups serve, at the same time, as the corresponding first and second output of the guidance device, which, in addition, has the first search signal conditioner and the third and the fourth commutator. The first outputs of these commutators are connected respectively to the first and the second output of the target seeker, whose first, second and third output is connected to the corresponding inputs of the search signal conditioner. The first and the second output of the search signal conditioner are connected to the third inputs, while its third output - to the paralleled second inputs of the third and the fourth commutator, the outputs of which, are, in turn, connected to the corresponding i nputs of the fifth and the sixth actuators.

Item 4. The system for lighting of an object in accordance with Item 1 distinguished by the following: the second guidance device has a target seeker equipped with a light marker (or a corner reflector), the seventh and the eighth actuators, the third and the fourth angular position pickups, whose outputs are at the same time the first and the second output of the guidance device, the fifth - eleventh commutators and the second search signal conditioner. The first inputs of the fifth, sixth and seventh commutator are connected to the corresponding first, second and third output of the target seeker, while the third inputs to the corresponding fourth, fifth and sixth output of the second target seeker. The first and the second output of the target seeker serve, at the same time, as the third and the fourth output of the guidance device. Besides, the second inputs of the abovementioned commutators are paralleled with the second inputs of the tenth and the eleventh commutator and serve as the commutation input of the guidance device, while the outputs of the fifth, sixth and seventh commutator are connected respectively to the first, second and third input of the second search signal conditioner, whose first and second output are connected respectively to the third inputs of the eighth and the ninth

commutator. The second inputs of these commutators are paralleled and connected to the third output of the second search signal conditioner, with the first inputs of the eighth and the ninth commutator connected respectively to the outputs of the tenth and the eleventh commutator, the first inputs of which are connected to the first and the second output of the second target seeker, while their third inputs are connected respectively to its fourth and the fifth output.

Item 5. The system for lighting of an object in accordance with Item 4 distinguished by the following: a laser installed in the third guidance device serves a source of radiation. The laser is connected to the laser excitation circuit, the first and the second input of which are connected to the third and the fourth output of the third guidance device.

Item 6. The system for lighting of an object in accordance with Item 5 distinguished by the following: the laser excitation circuit includes the second radio receiver, a remote switch, connected to the second source of the unit signal, and connected in series the second element "I", an inverter and the third element "I_8", the second input of which is connected through the remote switch to the source of unit voltage, while its output is at the same time the output of the third "I" element. Besides, the first and the second input of the second "I" element serve at the same time as inputs of the excitation system and are connected respectively to the third and the fourth output of the third guidance system.

Item 7. The system for lighting of an object in accordance with Item 3 distinguished by the following: the search signal conditioner includes a logical unit, the output of which is connected to the reset input of a linearly changing generator and to the paralleled record permitting inputs of the first and the second storage sampling device. The outputs and information inputs of the storage sampling devices are connected respectively to the first inputs and outputs of the first and the second summer; the second inputs of the summers are connected respectively to the outputs of the first and the second modulators, whose first inputs are paralleled and connected to the output of the linearly changing voltage generator. The second

inputs of the dfirst and the second modulators are connected respectively to the first and second output of the quadrature oscillator. Besides, outputs of the first and the second summer are connected respectively to the inputs of the first and second analog-to-digital converter, while inputs and the output of the logical unit together with outputs of the analog-to-digital converters are respectively the inputs and outputs of the controlling signal conditioner.

Item 8. The system for lighting of an object in accordance with Item 1

distinguished by the following: the first guidance device, optically bound with an object, is equipped with the first target seeker kinematically attached through the first and the second bracket to the fifth and the sixth actuators and respectively to the first and the second angular position pickup. The second guidance device, optically bound with the source of radiation, includes the second target seeker, kinematically attached through the third and the fourth bracket with the seventh and the eighth actuators and the third and the fourth angular position pickup. The first mirror kinematically attached to the first actuators is fixed on the internal frame of the first gimbal mount, the external frame of which is kinematically attached to the second actuators. The system also includes the second gimbal mount, which consists of the internal and external frame kinematically bound respectively to the third and the fourth actuators. The external frame of the second gimbal mount is joined to the concentric ring, on which the second mirror is fixed.

Item 9. The system for lighting of an object in accordance with Item 1 distinguished by the following: the second mirror is made in the form of two rings concentric on the outer ring of the gimbal mount and on the attached to it the internal and external pneumatic chamber pneumatically joined by radial tubes to each other and to the source of compressed gas (air). The pneumatic chambers and the radial tubes are connected with a reflecting sheet, which consists of an elastic dielectric film, coated with a light reflecting metal cover (e.g., aluminium).

Item 10. The system for lighting of an object in accordance with Item 9 distinguished by the following: the second mirror has an additional second reflecting sheet, which is adjusted at a fixed distance from the first one, with the metal layers of the sheets connected to the opposite poles of the re-introduced **emf** source.

Item 11. The system for lighting of an object in accordance with Item 9 distinguished by the following: the first and the second reflecting sheet together with the internal and external pneumatic chamber create a hermetically sealed cavity of reduced pressure attached to a re-introduced source of vacuum.

Item 12. The system for lighting of an object in accordance with Item 10 distinguished by the following: the internal pneumatic chamber consists of two pneumatically integrated sections joined by a corrugated elastic band in order they could move relative to each other. The metal coating of the second reflecting sheet is made in the form of concentric rings isolated from each other and connected to different controlled voltage sources.

The abstract

The invention deals with navigational engineering, specifically, optical-electronic systems for autotracking of moving objects.

The purpose of the presentational invention consists in diversifying functions of a target seeker by enabling it to search for a ground target and to light it from the outer space.

The implementation of this invention will technically result in more precise measuring of angular coordinates of the target because now the beam is pointed at the centre of the target image.

This technical result is achieved owing to some elements installed in the first device of the object guidance, such as an additional second guidance device optically connected with the radiation source, the first and the second subtracting amplifier, the first and the second actuator and a mirror. The first outputs of the first and the second guidance device are connected to the corresponding inputs of the first subtracting amplifier, while the second outputs - to the corresponding inputs of the second subtracting amplifier. The outputs of the first and the second subtracting amplifier are connected to the inputs of the corresponding actuators kinematically linked to the mirror.

The commutation unit includes the first and the second commutator, a radio receiver, a three-contact four-position radio-controlled switch, a source of unit voltage, an "I" element, an inverter and a radio transmitter – all appropriately connected to each other.

The first and the third guidance device is of identical circuit design and actuates electrically linked to each other the target seeker (TS), the search signal conditioner (SSC), the first and the second angular position pickup (APP_1, APP_2), commutators, the third and the fourth actuators (A_3, A_4), kinematically linked with a target seeker, and the angular position pickups.

The second guidance device has a target seeker equipped with a light marker (or a corner reflector), the fifth and the sixth actuators, the first and the second angular position pickup, whose outputs are at the same time the first and the second output of the guidance device, the third - ninth commutators and a search signal conditioner with the corresponding connections.

The laser excitation circuit includes the second radio receiver, a remote switch, connected to the second source of a unit signal, and connected in series the second element "I", an inverter and the third element "I", the second input of which is connected through the remote switch to the source of unit voltage, while its output is at the same time an output of the third "I" element. Besides, the first and the second input of the first "I" element serve at the same time as inputs of the excitation system, which are connected to the third and the fourth output of the third guidance system.

The mirror is made in the form of two rings concentric on the outer ring of the gimbal mount and on the attached internal and external pneumatic chamber pneumatically joined by radial tubes to each other and to the source of compressed gas (air). The pneumatic chambers and the radial tubes are connected with a reflecting sheet, which consists of an elastic dielectric film, coated by a light reflecting metal cover (e.g., aluminium).

In the second variant, the mirror has an additional second reflecting sheet, which is adjusted at a fixed distance from the first one, with the metal layers of the sheets connected to the opposite poles of the re-introduced emf source.

The internal pneumatic chamber consists of two pneumatically integrated sections joined by a corrugated elastic band in order they could move relative to each other. The metal coating of the second reflecting sheet is made in the form of concentric rings isolated from each other and connected to different controlled voltage sources.

Description: 33 pages, 10 figures, and 12 dependent items of the invention.

A system for lighting of an object

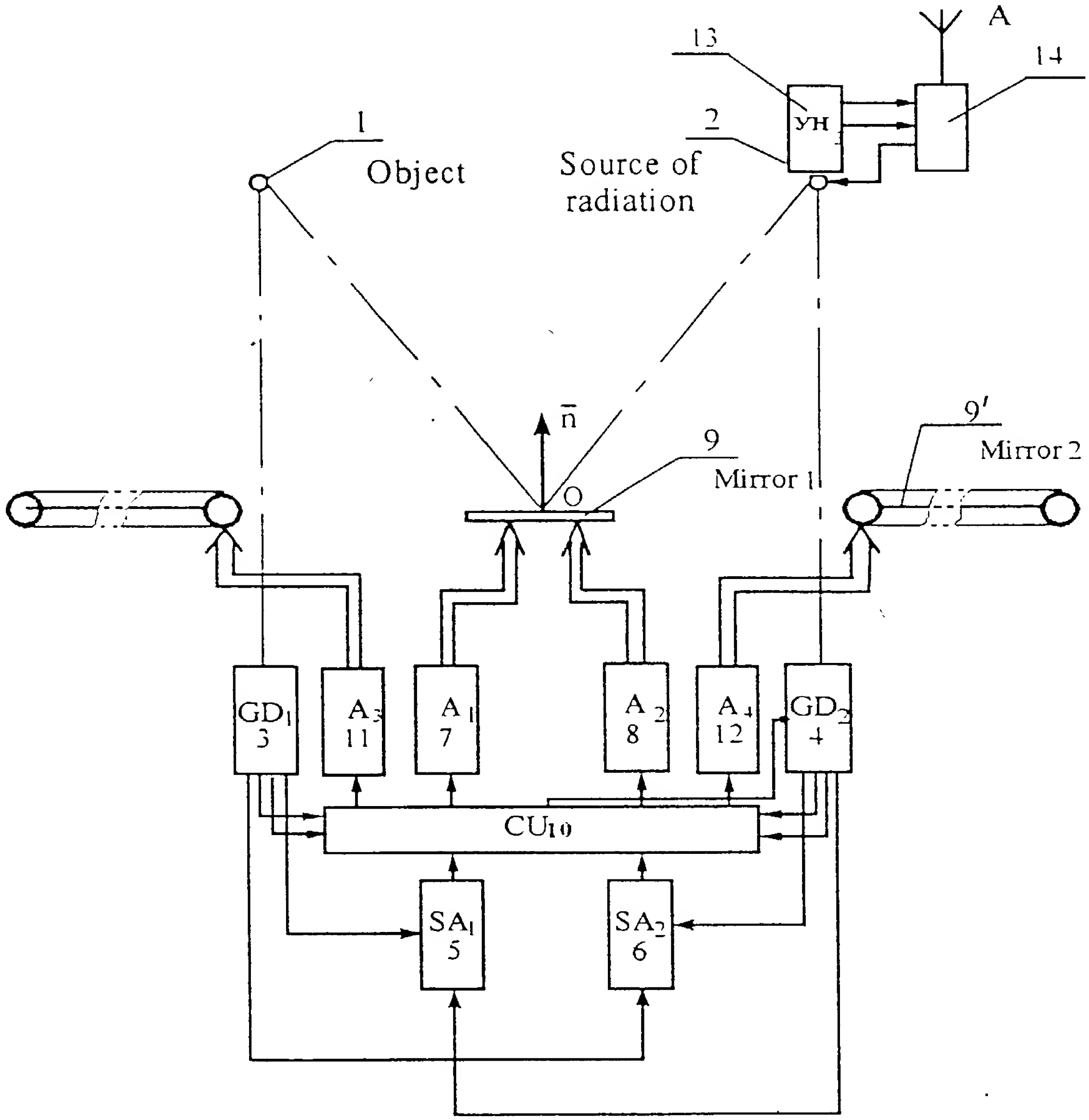

Fig. 1

A system for lighting of an object

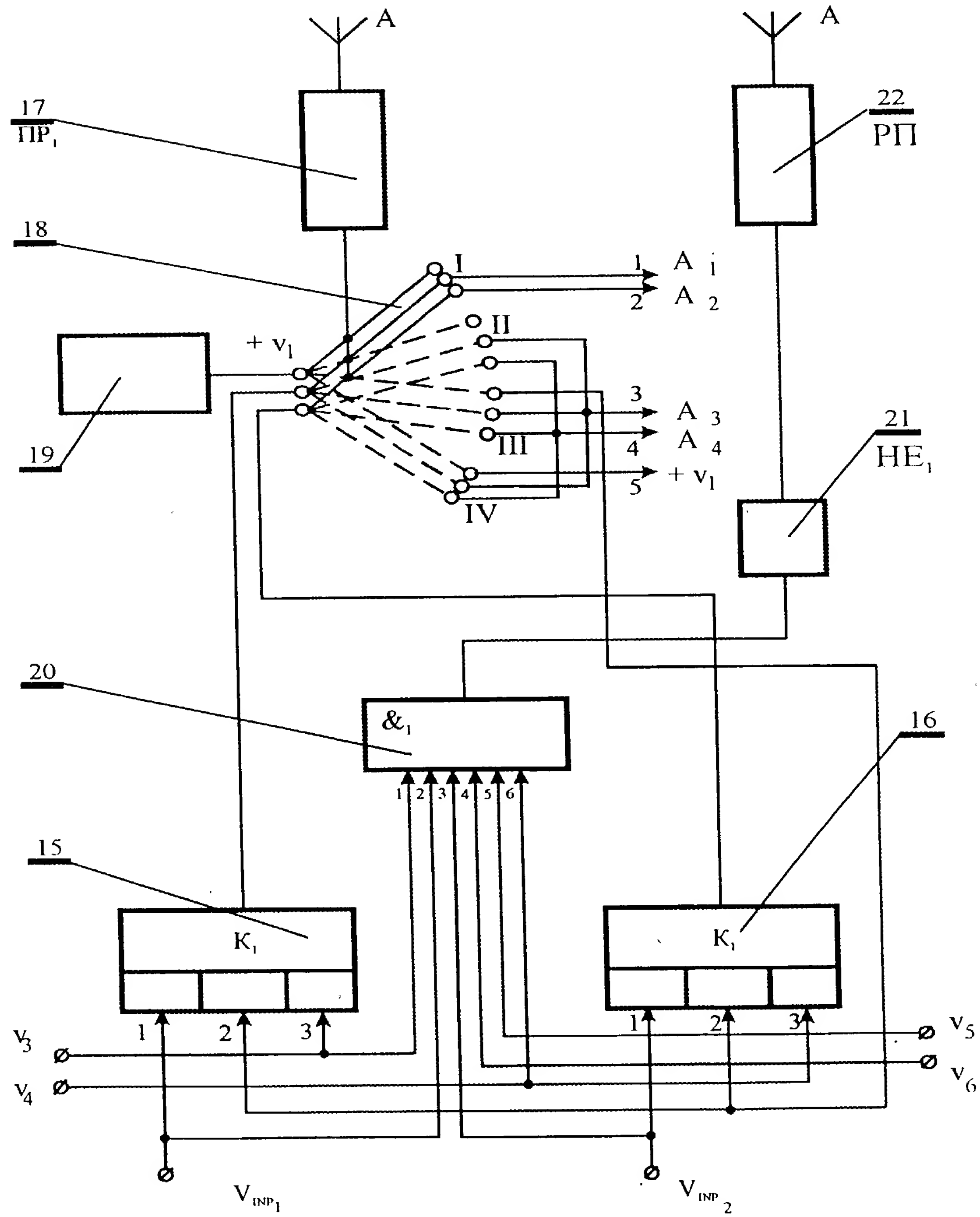

Fig. 2

The system for lighting of an object

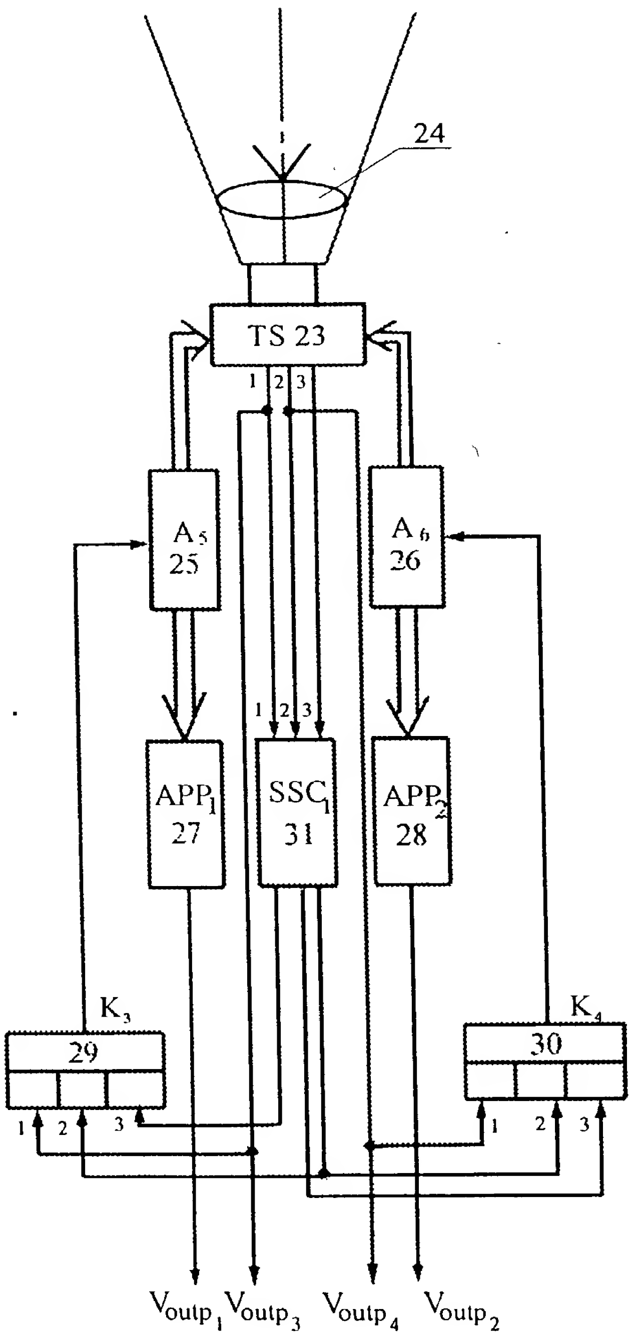

Fig. 3

A system for lighting of an object

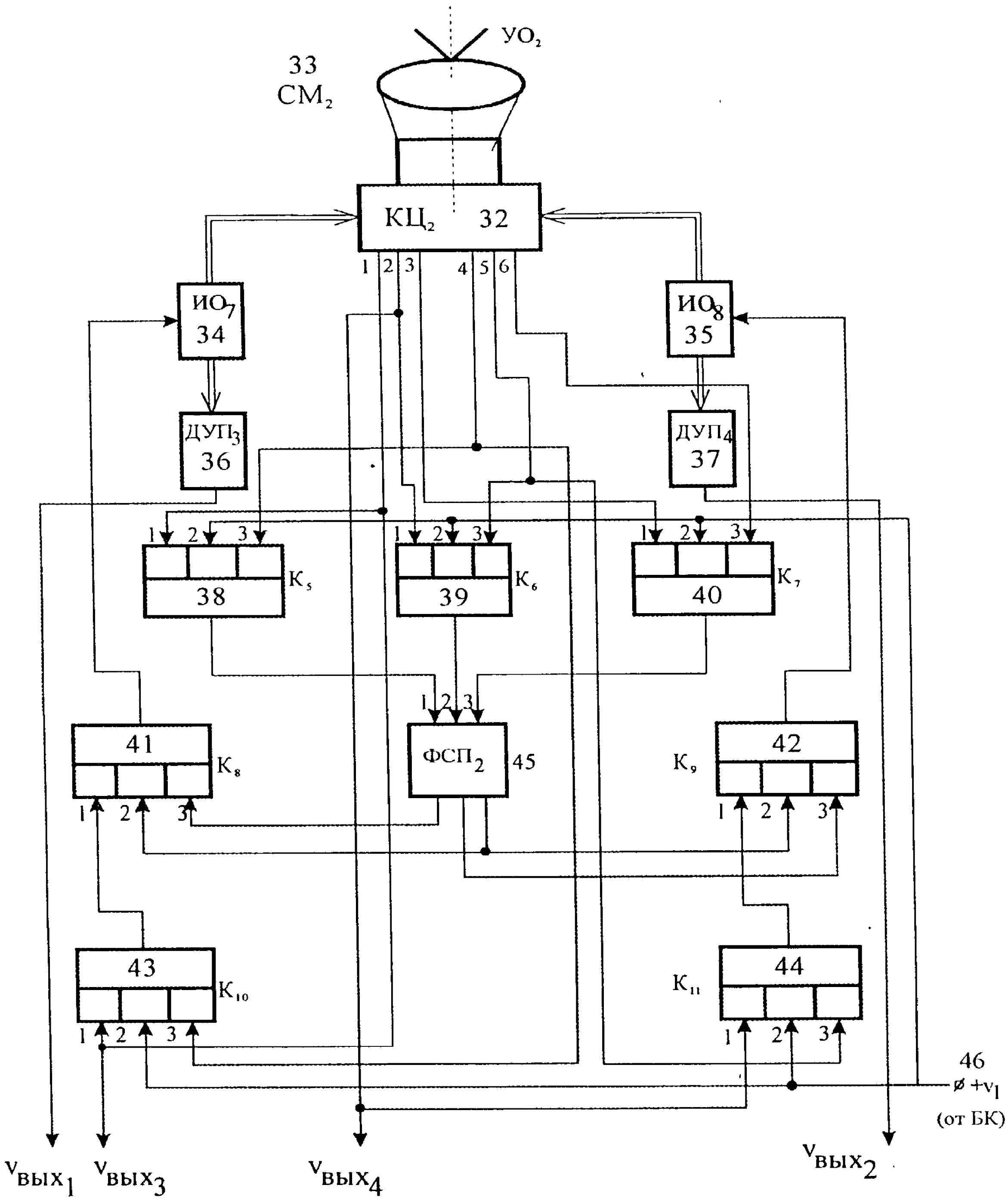

Fig. 4

A system for lighting of an object

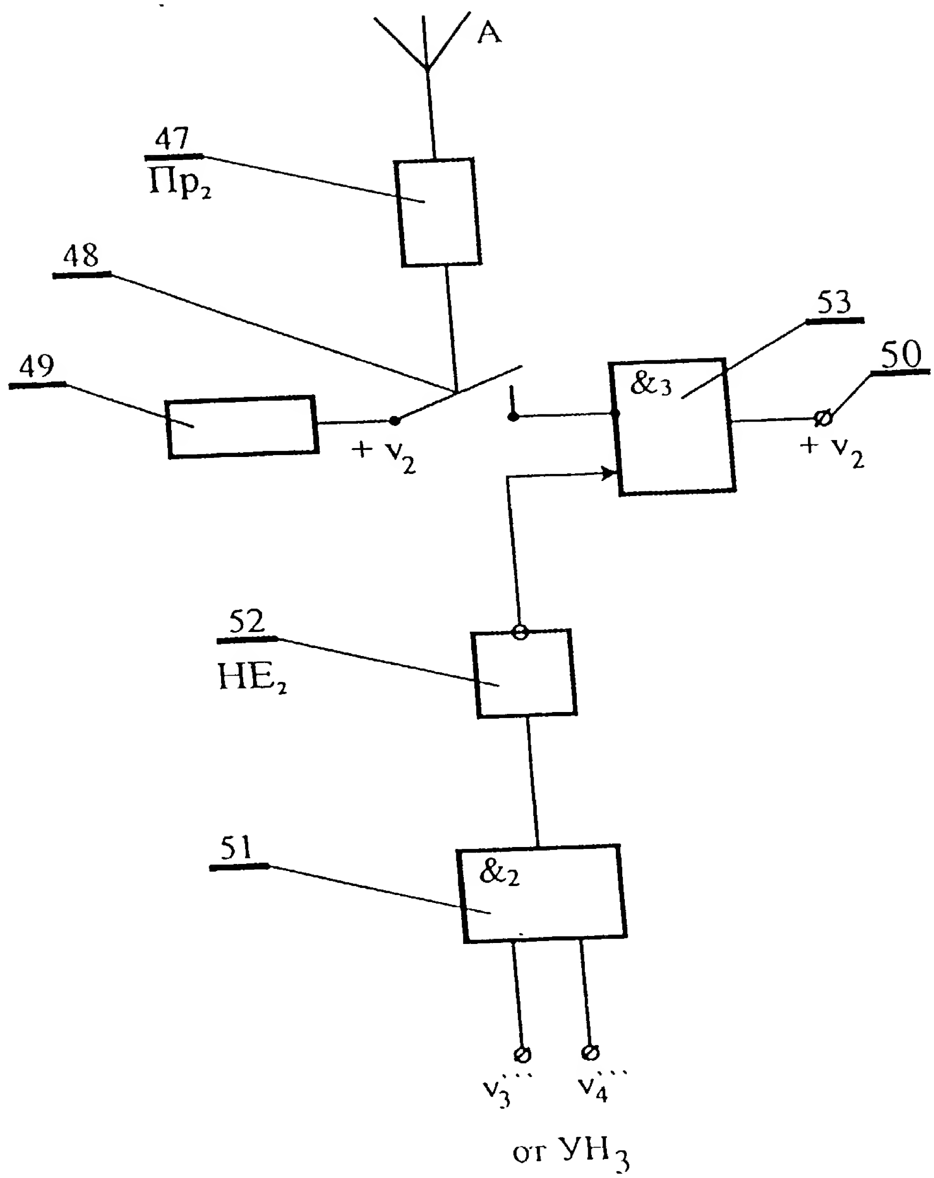

Fig. 5

A system for lighting of an object

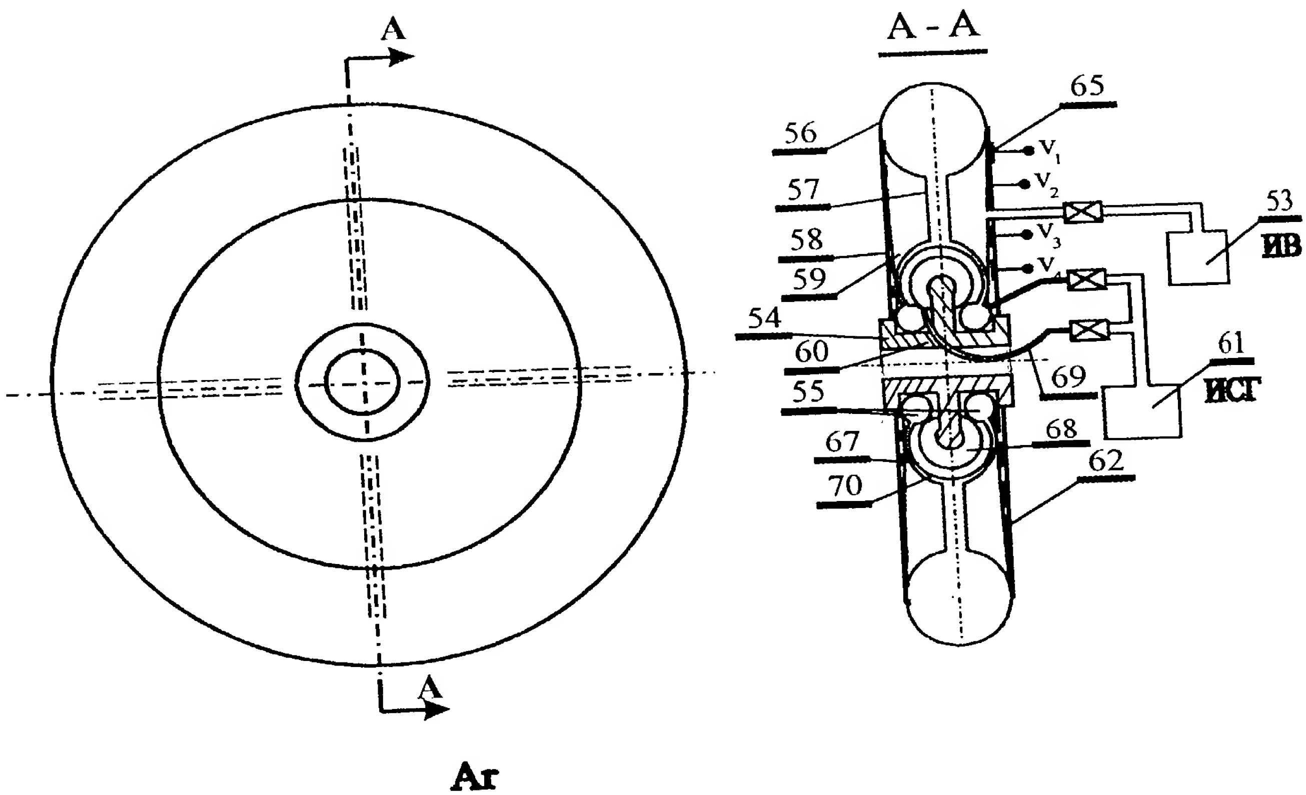

Fig. 6

A system for lighting of an object

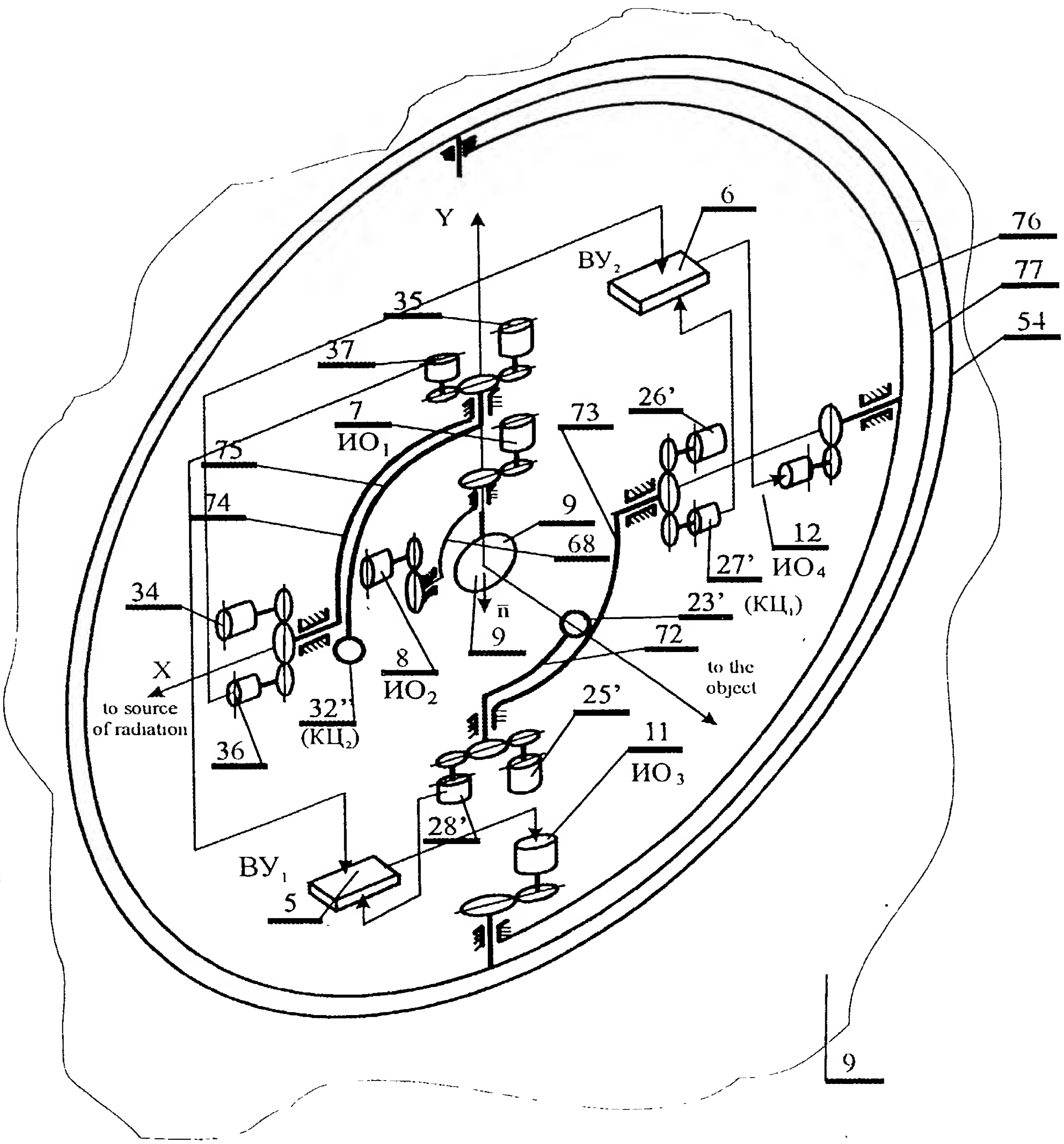

Fig. 7

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A system for lighting
of an object

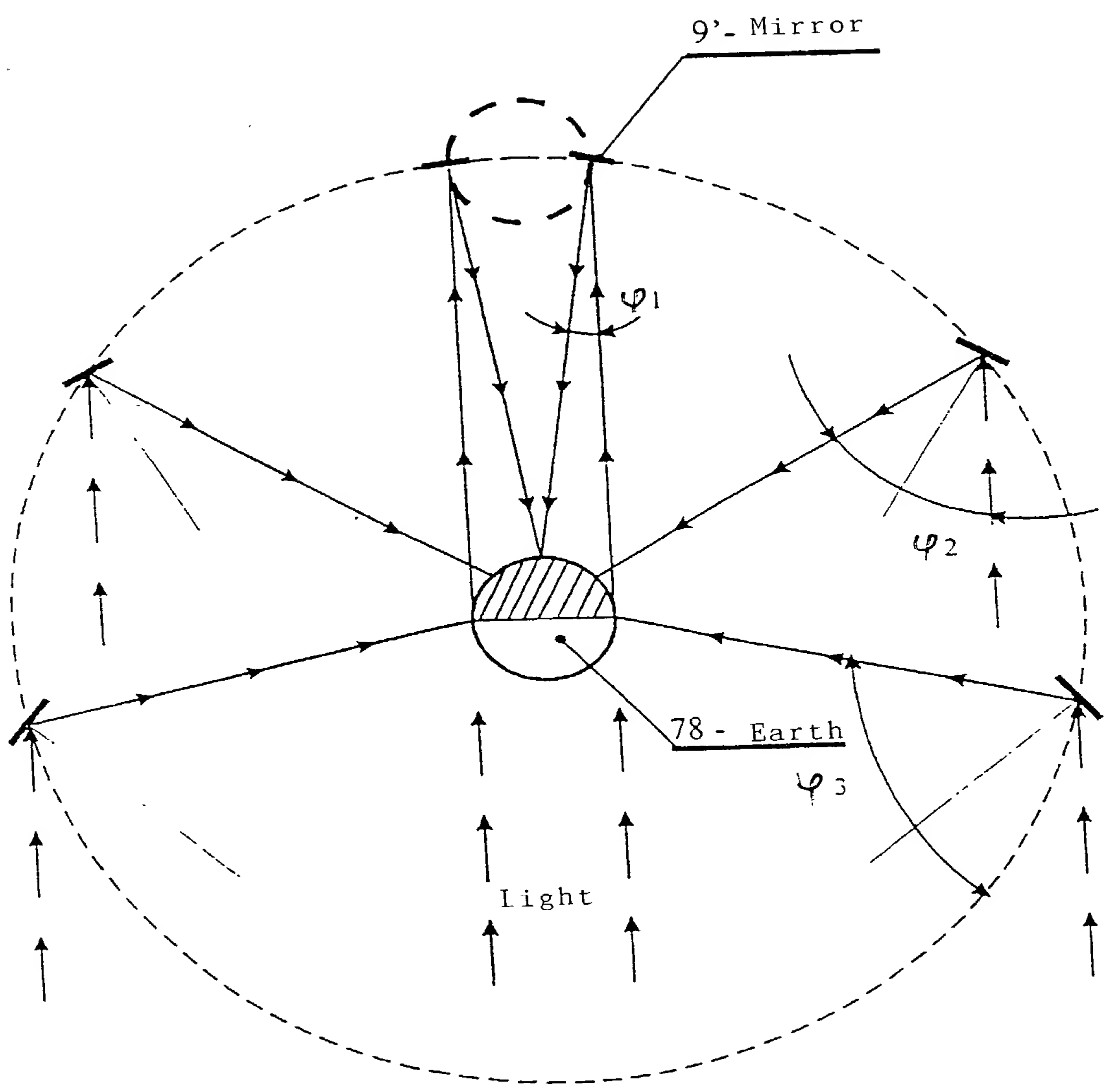

Fig. 8

A system for lighting of an object

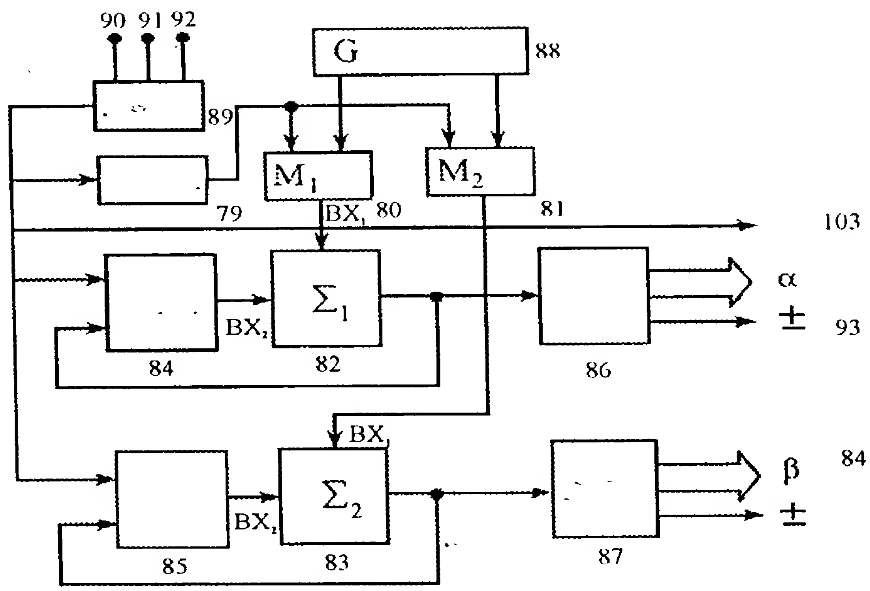

Fig. 9

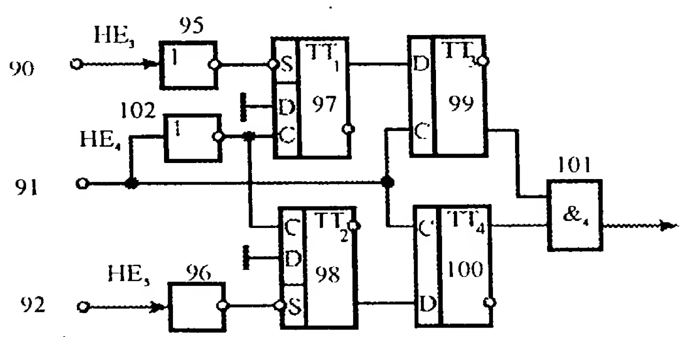

Fig. 10

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)	ATTORNEY'S DOCKET NUMBER ALIEV ET AL-1 PCT

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

SYSTEM FOR ILLUMINATING AN OBJECT

the specification of which (check only one item below):

[ ] is attached hereto.

[ ] was filed as United States application

Serial No. ____________

on ____________

and was amended

on ____________ (if applicable).

[X] was filed as PCT international application

Number PCT/RU00/00144

on 21 APRIL 2000

and was amended under PCT Article 19

on ____________ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:

COUNTRY (if PCT, indicate "PCT")	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 U.S.C. 119
RUSSIA	99111294	28 MAY 1999	[X] YES [ ] NO
			[ ] YES [ ] NO
			[ ] YES [ ] NO
			[ ] YES [ ] NO
			[ ] YES [ ] NO

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY
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ATTORNEY'S DOCKET NUMBER
ALIEV ET AL-1 PCT

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(Application Number) (Filing Date)

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclose in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application.

PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. 120:

U.S. APPLICATIONS			STATUS (Check One)		
U.S. APPLICATION NUMBER	U.S. FILING DATE		PATENTED	PENDING	ABANDONED
PCT APPLICATIONS DESIGNATING THE U.S.					
PCT APPLICATION NO	PCT FILING DATE	U.S. SERIAL NUMBERS ASSIGNED (if any)			

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (List name and registration numbers)

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SIGNATURE OF INVENTOR 201 X	SIGNATURE OF INVENTOR 202 X
DATE X 30.10.2001	DATE X 30.10.2001,